RESEARCH PROJECT SEGMENT

STATE: ALASKA
Name: Sport Fish Investigations of Alaska.

Project No.: F-5-R-9

Job No.: 7-B-2
Title: Population Studies of Anadromous Fish Populations - Southwestern Kenai Peninsula and Kachemak Bay.

Period Covered: July 1, 1967 to June 30, 1968.

ABSTRACT

A creel census conducted on three southwestern Kenai Peninsula streams revealed the area quota of 500 king salmon Oncorhynchus tshawytscha, was reached in five days. The fishery operated from May 26 through May 31. The total catch was estimated at 545 fish.

Escapement surveys on Deep Creek, Stariski Creek, Anchor River, and the Ninilchik Rivers indicated minimum king salmon escapements of 265, 195, 1,195, and 360 respectively.

Aerial survey counts were evaluated and found to be about 30 percent as effective as foot counts.

Age group 1.4 king salmon dominated samples from the Anchor and Ninilchik Rivers and slightly exceeded age group 1.3 in Deep Creek. Offspring from the smallest recorded spawning escapement have dominated the runs in the Anchor and Ninilchik Rivers for two successive years. The number of males returning in the 1.2 age group may be a valid indicator of escapement for the following two years.

King salmon smolts from Deep Creek and the Ninilchik River were examined and found to average 78.4 $\pm$ 2.1 mm and 94.3 $\pm$ 2.1 mm, respectively. All king salmon smolt scale samples examined had one freshwater annulus present.

Periodic creel census on the Anchor River indicated a harvest rate of 0.23 silver salmon O. kisutch, per hour. Nearly all silver salmon were found to be of age group 2.1.

Very few spawning silver salmon could be found either in the Anchor River or in the Clearwater slough system, tributary to the Fox River, draining into Kachemak Bay.

Four surveys were made to evaluate the recreational potential of anadromous fish stocks in the Tustumena Lake watershed. Silver salmon were present in prime physical condition; but red salmon O. nerka, were in a sexually advanced state and were deteriorating physically.

Steelhead trout Salmo gairdneri, were sampled in the Anchor River and compared to samples collected in 1960. In both samples, age group 3.2 was most prevalent. Compared to the 1960 sample, the 1967 sample contained a much larger percentage of fish making their second spawning migration.

RECOMMENDATIONS

1. To continue and emphasize the collection and comparison of population data from king salmon carcasses and from sport caught king salmon.

2. Develop and employ mark and recapture methods to numerically estimate stocks of king salmon, silver salmon, and steelhead trout.

3. That a study of the freshwater life history of king salmon, silver salmon, and steelhead trout be initiated and conducted simultaneously.

The study should emphasize:

(a) Fry age and growth
(b) Fry distribution
(c) Smolt emigration timing
(d) Identification of major mortality factors
(e) Establishment of smolt enumeration indexes

OBJECTIVES

1. To determine the recreational catch of anadromous fishes and evaluate angling pressure in the fresh waters of the southwestern Kenai Peninsula and marine waters of Kachemak Bay.

2. To investigate and evaluate population trends for anadromous fish species in the major recreational fresh waters in the southwestern Kenai Peninsula and Kachemak Bay.

3. To evaluate the effect of current management techniques, to make recommendations for future management, and to direct the course of future studies relating to anadromous fishes within the job area.

TECHNIQUES USED

Creel census of the Kenai Peninsula king salmon punch card fishery was described by Engel (1966). Due to light fishing effort on the Kenai River in 1966, no creel census was conducted on that stream in 1967.

Angler harvest and population data of silver salmon and steelhead trout stocks were collected by streambank creel census.

King salmon spawning populations were estimated by foot and aerial surveys as described by Logan (1963) and Engel (1964). King salmon carcasses were examined for sex and fork length concurrent with escapement surveys.

Harvest data on silver salmon and steelhead trout were collected during a partial creel census of the Anchor River.

Cellulose-acetate scale impressions were examined by microprojector for age determinations.

FINDINGS

Study streams on the southwestern Kenai Peninsula and past information collected on this project are described in Dingell-Johnson Progress Reports by Dunn (1960), Logan (1961, 1962, 1963), and Engel (1964, 1965). A recapitulation of past sport fishing regulations and a description of the 1966 king salmon punch card fishery were made by Engel (1966). Regulations during the 1967 king salmon punch card fishery were identical to 1966, except the fishery was continuous until the area quota of 500 king salmon was reached. In 1966 only weekend and holiday fishing was allowed.

King Salmon Studies

Harvest:

To estimate when the quota was reached, an intensive creel census was maintained on Deep Creek, Anchor River, and Ninilchik River. Due to the low fishing effort and catch on the Kenai River in 1966, no creel census was conducted on that stream in 1967.

The fishery was closed after 328 king salmon were observed by department personnel. An observed catch of 316 king salmon in 1966, during an equally intensive creel census, had resulted in a total catch of about 500 fish (Engel 1966). In 1967, the king salmon quota was reached in only five days. The fishery operated from May 26 through May 31.

Stream flows during the fishery were moderate and the catch was well distributed among all streams except the Kenai River. As in 1966, few anglers fished the Kenai River due to its glacial color and because the main king salmon migration does not occur until July. A breakdown of the total reported punch card catch of 510 king salmon is presented in Table 1.

TABLE 1 - King Salmon Catch Timing and Distribution, Kenai Peninsula, 1967.

Stream	Date 5/27	5/28	5/29	5/30	5/31	Total
Anchor River	67	41	43	40	31	222
Ninilchik River	62	15	10	13	10	110
Deep Creek	42	33	37	41	18	171
Kenai River	1	1	2	2	1	7
Total	172	90	92	96	60	510

The catch in Deep Creek and the Anchor River remained relatively stable throughout the fishery. However, the catch in the Ninilchik River declined sharply after the first day. The decrease in the Ninilchik River is probably related to clear stream flow conditions and the small size of the stream.

The recorded harvest levels in the Anchor River and Deep Creek throughout the fishery disagree with catch characteristics of 1966. Engel (1966)reported that catches on Saturdays far exceeded Sunday catches during the 1966 weekend only fishery.

Of 5,977 punch cards issued, 4,909 (82.1 percent) were voluntarily returned. The anglers returning cards caught 456 king salmon for a success

rate of 9.1 percent. By direct extrapolation, the 1,068 non-reporting anglers are estimated to have caught 97 additional kings for a total estimated harvest of 553 king salmon.

The total catch was also estimated by the following ratio:

$$\frac{\text{Fish Creel Checked}}{\text{Punch card returned / Punch card not returned}} = \frac{\text{Fish Creel Not checked}}{\text{Punch card returned / Punch card not returned}}$$

$$\frac{274}{54} = \frac{175}{X} = 34$$

This ratio estimates a total catch made of:

Total fish creel checked	328
Punch cards returned, fish not creel checked	175
Punch cards returned from Kenai River catch	7
Punch cards not returned, fish not creel checked	34
Total estimated catch	544

This ratio assumes that the rate of punch cards returned is the same for anglers whose fish were creel checked as those who were not checked. The Kenai River catch of seven fish was omitted from the calculation as no creel census was performed on that stream.

One hundred thirty-one (12.3 percent) of 1,068 non-reporting anglers were contacted by phone to estimate the non-reported catch. These anglers reported catching only four king salmon for a success rate of 3.05 percent. If the 1,068 non-reporting anglers are multiplied by the 3.05 percent succes rate indicated by telephone sampling, an additional catch of 33 king salmon is estimated. The additional estimated catch, plus the reported punch card harvest of 456 king salmon, yields a total harvest estimate of only 489 king salmon. This estimate is obviously incorrect. Since 54 king salmon were checked for which no punch card was returned, the minimum success rate of non-reporting anglers must have been at least 5.1 percent. If the catch estimate from the ratio formula is correct, the success rate of non-reporting anglers was (88/1068) or 8.2 percent, not significantly less than the 9.1 percent success rate of reporting anglers.

Within the known catch of 510 fish, 22.0 percent (92/418) of the successful anglers caught the seasonal limit of two king salmon. This percentage compares to a rate of 21.2 percent for the 1966 fishery (Engel, 1966).

Escapement:

Foot and aerial surveys were again conducted to estimate spawning king salmon stocks in the Anchor River, Ninilchik River, Deep Creek and Stariski Creek. Surveys were timed to coincide with the historical pattern of peak spawning from July 25 until August 2. Clear skies and low, clear, water conditions prevailed throughout the 1967 surveys.

The Anchor River spawning population was estimated to be 1,195 king salmon. This estimate is about 15 percent below the average for the previous five-year interval. A summary of estimates for 1967 and prior years is presented in Table 2. Adding the estimated sport harvest of 235 fish, the 1967 Anchor River king salmon run is estimated to have totalled 1,440 fish.

The male-female sex ratio of 0.7:1 in the 1967 escapement is the

lowest recorded. The increased percentage of females in the run compensated for the reduced total number of fish, so that the estimated number of spawning females compares favorably with escapements during the prior four years. Also, the predominance of large, six-year-old fish may well have resulted in the largest egg deposition in the Anchor River since surveys were initiated in 1960. A summary of the estimated number of spawning females by year is presented in Table 2.

TABLE 2 - Summary of Escapement, Sex Ratios and Estimated Number of Spawning Female King Salmon, Anchor River, 1960-1967.

Year	Estimated Total Escapement	Male:Female Sex Ratio	Estimated Spawning Females	Method of Determination
1960	1,200	0.9:1	631	Aerial & Foot Survey
1961	850	1.2:1	386	Aerial & Foot Survey
1962	970	0.8:1	539	Aerial & Foot Survey
1963	1,340	1.0:1	670	Aerial & Foot Survey
1964	1,700	1.4:1	708	Aerial & Foot Survey
1965	1,600	1.7:1	593	Aerial & Foot Survey
1966	1,325	0.8:1	736	Foot Surveys
1967	1,195	0.7:1	700	Aerial & Foot Survey

Estimated king salmon spawning populations in 1967 and during past years in Deep Creek, Stariski Creek, and the Ninilchik River are shown in Table 3. In each case, despite optimum survey conditions, the 1967 estimate is the lowest on record. The greatest reduction occurred in Deep Creek where the estimated spawning escapement of 264 king salmon was less than one-half of any prior estimate.

TABLE 3 - Estimated King Salmon Escapements for Deep Creek, Stariski Creek, and the Ninilchik River, 1962-1967.

Stream	1962	1963	1964	1965	1966	1967
Deep Creek	745	605	800	690	540	265
Ninilchik River	525	450	910	1,025	670	360
Stariski Creek	355	265	582	330	---	195

The male-female sex ratio in the Ninilchik River was 0.7:1. By direct extrapolation, the total 1967 escapement of 361 king salmon is estimated to have consisted of 212 females and 149 males. The male-female sex ratio in Deep Creek was 1.2:1, using rounded estimates of 144 males and 120 females, respectively.

The survey technique currently used to estimate king salmon spawning escapement in Kenai Peninsula streams serves to provide a comparative index to population change rather than an accurate indicator of total population size. Table 4 describes the relative effectiveness of Kenai Peninsula king salmon survey techniques during recent years. Table 4 shows that spawning distribution changes sharply from year to year. In the Anchor River the percentage of the run within the eight-mile index area has varied between 11.2 percent and 30.5 percent. In the Ninilchik River, the percentage within the four-mile index area has varied from

31.3 percent to 59.0 percent. Assuming the foot observer sees nearly all the king salmon within the index area, the aerial observer is usually 20 to 35 percent effective. Effectiveness is greatest in Deep Creek which is not as darkly stained as the Ninilchik or Anchor Rivers. Unfortunately, the Anchor River, which contains the largest run of king salmon and sustains the greatest fishing pressure, is the most difficult to survey by the present method.

TABLE 4 - Relative Effectiveness of King Salmon Aerial and Foot Surveys on Kenai Peninsula Streams.

Name of Stream	Year	Estimated Percent Of Run Within Index Area By Aerial Survey	Percent Success Of Aerial vs. Foot Surveys Within Index Areas
Anchor River	1962	31/212 = 14.6	31/196 = 15.8
	1963	112/454 = 24.7	112/239 = 46.9
	1964	89/299 = 22.3	89/379 = 21.7
	1965	39/347 = 11.2	39/180 = 21.7
	1966	No Aerial Survey	/300 = ---
	1967	64/210 = 30.5	64/363 = 17.3
Deep Creek	1962	28/89 = 31.5	28/191 = 14.7
	1963	138/400 = 34.5	138/258 = 53.5
	1964	57/275 = 20.7	57/165 = 34.5
	1965	31/167 = 18.6	31/128 = 24.2
	1966	No Aerial Survey	/107 = ---
	1967	20/139 = 14.4	20/38 = 52.6
Ninilchik River	1962	15/47 = 31.9	15/143 = 10.5
	1963	73/179 = 37.1	73/193 = 37.8
	1964	76/200 = 38.0	76/347 = 21.9
	1965	70/224 = 31.3	70/319 = 21.9
	1966	No Aerial Survey	/231 = ---
	1967	59/100 = 59.0	59/213 = 27.7
Stariski Creek	1962	3/18 = 16.7	3/44 = 6.8
	1963	11/53 = 20.8	11/74 = 14.9
	1964	61/152 = 40.1	61/234 = 26.1
	1965	23/94 = 24.5	23/80 = 28.8
	1966	No Aerial Survey	No Count
	1967	13/31 = 41.9	13/82 = 15.9

Population structure - Anchor River:

Data on the population structure of king salmon in the Anchor River were collected from both sport caught fish and carcasses. Figure 1 depicts the marked similarity in size (and age class frequency) between sport caught king salmon and carcasses. With the exception of a few precocious males taken in the sport fishery whose small carcasses are difficult to find, the length-frequency of each sample is nearly identical. The ratio of males to females in the sport fishery was 0.72:1 while the

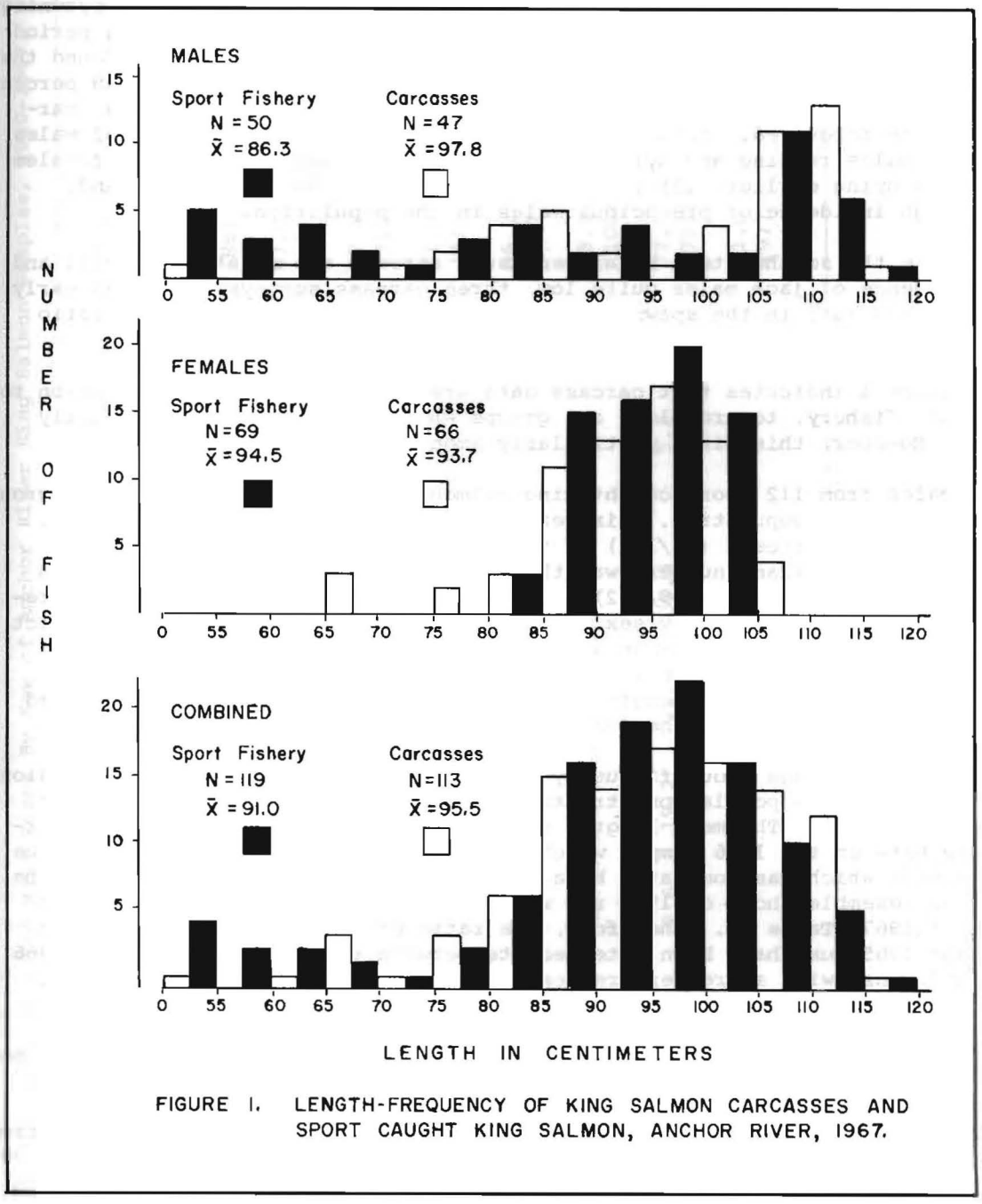

FIGURE 1. LENGTH-FREQUENCY OF KING SALMON CARCASSES AND SPORT CAUGHT KING SALMON, ANCHOR RIVER, 1967.

ratio among recovered carcasses was 0.71:1. These data indicate that carcass sampling may be a valid tool in evaluation population characteristics of king salmon stocks in southwestern Kenai Peninsula streams. However, caution should be exercised in interpreting carcass data. Males appeared to die somewhat sooner than females, thus carcass counts conducted early in the spawning period would be biased toward males while counts late in the spawning period would be biased toward females. Ordmann and Richards (1962, 1962a) found that on the South Fork of the Salmon River, daily surveys recovered only 19 percent of male carcasses known to be above a weir while 67 percent of female carcasses were recovered. These researchers attributed lower recovery of males to: (1) males ranging and dying farther from the spawning redd than females, (2) males dying earlier, (3) smaller average size of male carcasses and, (4) a high incidence of precocious males in the population.

Since the southwestern Kenai Peninsula streams are relatively small and the incidence of jack males quite low, three carcass surveys conducted early, mid-way, and late in the spawning period should provide reliable sex ratio information.

Figure 1 indicates that carcass data are slightly biased, in relation to the sport fishery, toward older age groups whose carcasses are more easily found. However, this bias, particularly among females, is minimal.

Scales from 112 sport caught king salmon were read to determine age group frequency of the population. Six-year-old fish (1.4) dominated the catch, comprising 66.1 percent (74/112) of the sample. The only other age class present in significant numbers was the five-year-old (1.3) age group which constituted 22.3 percent (25/112) of the total. A summary of age group frequencies and mean lengths by sex is shown in Table 5. As expected, a direct correlation exists between mean length and the relative frequency of the principal age groups 1.3 and 1.4. A greater percentage of age group 1.4 results in a greater mean length. The runs in 1961 and 1967 were dominated by age group 1.4 and have the largest mean lengths.

By relating age group frequency to mean lengths, some general conclusions can be made of the population structure during 1964 and 1965 when no sport fishery operated. The mean lengths of carcasses in 1964 and 1965 are intermediate between the 1966 sample which was dominated by age group 1.3 and the 1967 sample which was dominated by age group 1.4. Length frequencies of the 1965 run resemble those of 1966 run while 1964 length frequencies resemble those of 1967 (Table 6). Therefore, the ratio of age groups 1.3 to 1.4 in 1964 and 1965 must have been intermediate between that displayed by the 1966 and 1967 runs, with a greater frequency of age group 1.4 occuring in 1964.

Tables 2 and 5 also indicate that dominant year classes occur in the Anchor River king salmon stocks and run size may not be closely correlated to size of the parent escapement. The 1.4 age group dominant in the 1967 sampling and the 1.3 age group dominant in 1966 are both progeny of the 1961 brood year, the smallest run on record. Furthermore, carcass information from 1965 males (Table 6) indicates a strong showing of age group 1.2 in the 55-70 cm range from this same year class. Females rarely return until their fifth year (age group 1.3).

TABLE 5 - Age Class Frequency and Mean Sizes By Sex of Anchor River King Salmon Samples, 1960-1967.

Year	Sample Size For Age Determination	Age Group By Percent					Mean Length (cm) and Number In Sample		
		1.1	1.2	1.3	1.4	All Other	Male	Female	Combined
1960	199	2.7	6.5	76.0	11.0	3.8	82.3 (88)	82.3 (95)	84.1 (183)
1961	112	2.9	10.6	21.1	64.4	1.0	87.0 (58)	93.8 (49)	90.1 (107)
1962	47	---	31.9	40.4	27.7	---	79.5 (31)	85.9 (40)	83.1 (71)
1963	99	10.1	19.2	49.5	20.2	1.0	71.9 (77)	90.6 (75)	81.1 (152)
1964	---	Carcasses Only - No Sport Fishery					86.1 (60)	91.5 (44)	88.4 (104)
1965	---	Carcasses Only - No Sport Fishery					83.5 (106)	90.7 (62)	86.1 (168)
1966	151	2.6	19.2	42.4	30.5	5.3	77.6 (79)	89.5 (95)	84.1 (174)
1967	112	1.8	8.9	22.3	66.1	0.9	91.8 (97)	94.1 (135)	93.2 (232)

TABLE 6 - A Summary of King Salmon Length-Frequency Data, Anchor River, 1964 - 1967.

Year	Males															Total Fish	Ave. Mean Length
1964	5		1	1	4	5	3	4	4	9	6	7	8	3		60	86.1
1965	2	2	8	8	17	4	3	2	8	12	18	17	3	2		106	83.5
1966		4	16	9	2	1	3	8	15	12	5	2	1	1		79	77.6
1967	6		3	5	3	2	5	8	7	6	3	6	22	19	2	97	91.8
Length (cm)	0-50	55	60	65	70	75	80	85	90	95	100	105	110	115	120		

Year	Females															Total Fish	Ave. Mean Length
1964								3	16	13	7	5				44	91.5
1965							3	9	21	14	9	5		1		62	90.7
1966				1		1	2	18	30	20	15	8				95	89.5
1967					3		2	6	26	29	37	28	4			135	94.1
Length (cm)	0-50	55	60	65	70	75	80	85	90	95	100	105	110	115	120		

Year	Combined															Total Fish	Ave. Mean Length
1964	5		1	1	4	5	3	7	20	22	13	12	8	3		104	88.4
1965	2	2	8	8	17	4	6	11	29	26	27	22	3	3		168	86.1
1966		4	16	10	2	2	5	26	45	32	20	10	1	1		174	84.1
1967	6		3	5	6	2	7	14	33	35	40	34	26	19	2	232	93.2
Length (cm)	0-50	55	60	65	70	75	80	85	90	95	100	105	110	115	120		

Progeny of the 1958 brood year (brood size unknown) appeared strongly in 1962 as age group 1.2, dominated the fishery in 1963 as age group 1.3 and in 1964 appeared strongly as 1.4 age group in carcasses exceeding 90 cm. Progeny of the 1955 brood year dominated the 1960 and 1961 sport fisheries as age groups 1.3 and 1.4 respectively. The earlier history of this year class is unknown.

Thus, the run size of the 1.2 male age group may be an indicator of the future strength of that year class for the succeeding two years. It should be noted that run size of the 1.2 male age group is only expressed as a percentage of the sample and the presence of a strong age group tends to depress the percentages of all other age groups. A better indicator of the strength of the male 1.2 age group might be the number of male carcasses in the 50-70 cm length increment found within the stream survey index area.

Population Structure - Ninilchik River:

Population data for king salmon in the Ninilchik River were collected for the fourth successive year. Data from 1964 and 1965 consist of length frequencies collected from carcasses. Data were collected from sport caught king salmon in 1966 and 1967.

In 1967, scales from 78 sport caught kings were used to estimate the age group frequency of the run. Age group 1.4 made up 56.4 percent (44/78) and age group 1.3 made up 30.8 percent (24/78) of the catch. A summary of the estimated age class breakdown of the 1966 and 1967 runs is provided in Table 7.

TABLE 7 - Age Group Frequency of King Salmon by Percent, Ninilchik River, 1966 - 1967.

		Age Group						
Year	Sample Size	1.1	1.2	1.3	1.4	1.5	2.2	2.3
1966	82	---	22.0	45.2	30.4	---	---	2.2
1967	78	2.6	6.4	30.8	56.4	1.3	1.3	1.3

Length frequency data by sex are compiled in Table 8 for the years 1964 through 1967. Similar to the Anchor River, length frequency data compiled from carcasses in 1965 resemble that of 1967 when age group 1.4 predominated. Length frequency data from 1964 carcasses are similar to 1966 when age group 1.3 was most prevalent in the sport fishery. Also, like the Anchor River, progeny of the 1961 brood year showed strongly in 1965 as age group 1.2 males and dominated the sport fishery during both 1966 and 1967.

TABLE 8 - Summary of Length Frequencies, Sample Sizes and Mean Lengths, King Salmon, Ninilchik River, 1964-1967.

Year	Males															Total Fish	Ave. Mean Length
1964	6		1	6	5	7		4	7	5	4	4	7	1		57	80.5
1965	5	1		4	2			3	7	5	7	6	3	1	2	46	84.9
1966		1	9	12	3		3	7	8	8	4	1	1	2		59	77.8
1967	2	2	3		1	1	1	4	3	4	2	5	4	1		33	80.4
Length (cm)	0-50	55	60	65	70	75	80	85	90	95	100	105	110	115	120		

Year	Females															Total Fish	Ave. Mean Length
1964							1	16	12	11	3					43	86.9
1965							2	9	15	12	7	2				47	89.3
1966						1	3	12	12	14	7	2				51	88.3
1967							4	6	8	11	13	6	1			49	91.4
Length (cm)	0-50	55	60	65	70	75	80	85	90	95	100	105	110	115	120		

Year	Combined															Total Fish	Ave. Mean Length
1964	6		1	6	5	7	1	20	19	16	7	4	7	1		100	83.3
1965	5	1		4	2		2	12	22	17	14	8	3	1	2	93	87.1
1966		1	9	12	3	1	6	19	20	22	11	3	1	2		110	82.7
1967	2	2	3		1	1	5	10	11	15	15	11	5	1		82	87.3
Length (cm)	0-50	55	60	65	70	75	80	85	90	95	100	105	110	115	120		

Population Structure - Deep Creek:

Data collected during the 1967 punchcard sport fishery are the first information available on the population structure of king salmon in Deep Creek. The age group structure differed sharply from that of the Ninilchik and Anchor Rivers. In general, the Deep Creek run was made up of younger fish than the runs in the other streams. Fish which had remained in the ocean only two years, particularily males, comprised 26.2 percent of the catch. In common with the other streams, age group 1.4 exceeded age group 1.3. Age group frequencies by sex are presented in Table 9. If the return of two ocean males is a valid indicator of runs for the two succeeding years, Deep Creek should demonstrate a larger escapement, dominated by age group 1.3, in 1968. Over 40 percent of all males were individuals of age groups 1.2 and 2.2. The high percentage of young males in 1967 was at least partially caused by the very weak run of age groups 1.3 and 1.4.

TABLE 9 - Age Group Frequency of King Salmon by Percent, Deep Creek, 1967.

	Age Group									Sample Size
	1.1	2.1	0.2	1.2	2.2	2.3	1.3	1.4	2.4	
Males	12.1	1.7	1.7	34.5	6.9	---	27.6	15.5	---	58
Females	---	---	---	6.2	---	2.0	30.6	59.2	2.0	49
Combined	6.5	0.9	0.9	21.6	3.7	0.9	29.0	35.6	0.9	107

Seven of 107 sampled fish are believed to have spent two years in fresh water before their smolt migration. The greater occurrence of 2-check smolts in Deep Creek may well be related to the lower freshwater growth rate as compared to the Ninilchik River (see section on scale characteristics).

Length frequencies from Deep Creek king salmon can be quite accurately separated in groups spending one, two, three, or four years in the ocean. Length frequencies and mean sizes for groups spending different numbers of years in the ocean are shown in Figure 2.

As noted earlier, the male-female sex ratio of 1.2:1 was the only instance where males exceeded females and was related to the larger return of young males.

Scale Characteristics:

The scale characteristics of king salmon smolts in the Ninilchik River and Deep Creek were studied to verify the present technique of reading king salmon scales. All smolts from both streams were collected by seine on June 23, 1967. All smolts sampled had one freshwater annulus plus current year growth. Thirty-five smolts from the Ninilchik River averaged 94.3 $\pm$ 2.1 mm (95% C. I.) as opposed to 78.4 $\pm$ 2.1 mm (95% C. I.) for 31 smolts from Deep Creek. A summary of circuli counts and size distribution of smolts from both streams is shown in Tables 10 and 11.

Data indicate that considerable growth occurs after the first annulus is laid down and that at least a portion of the smolt population remains in the stream during a significant portion of their second growing season. It is possible that in past years some adult king salmon scales interpreted to contain two freshwater annuli were individuals who emigrated late in the growing season following the formation of the first annulus.

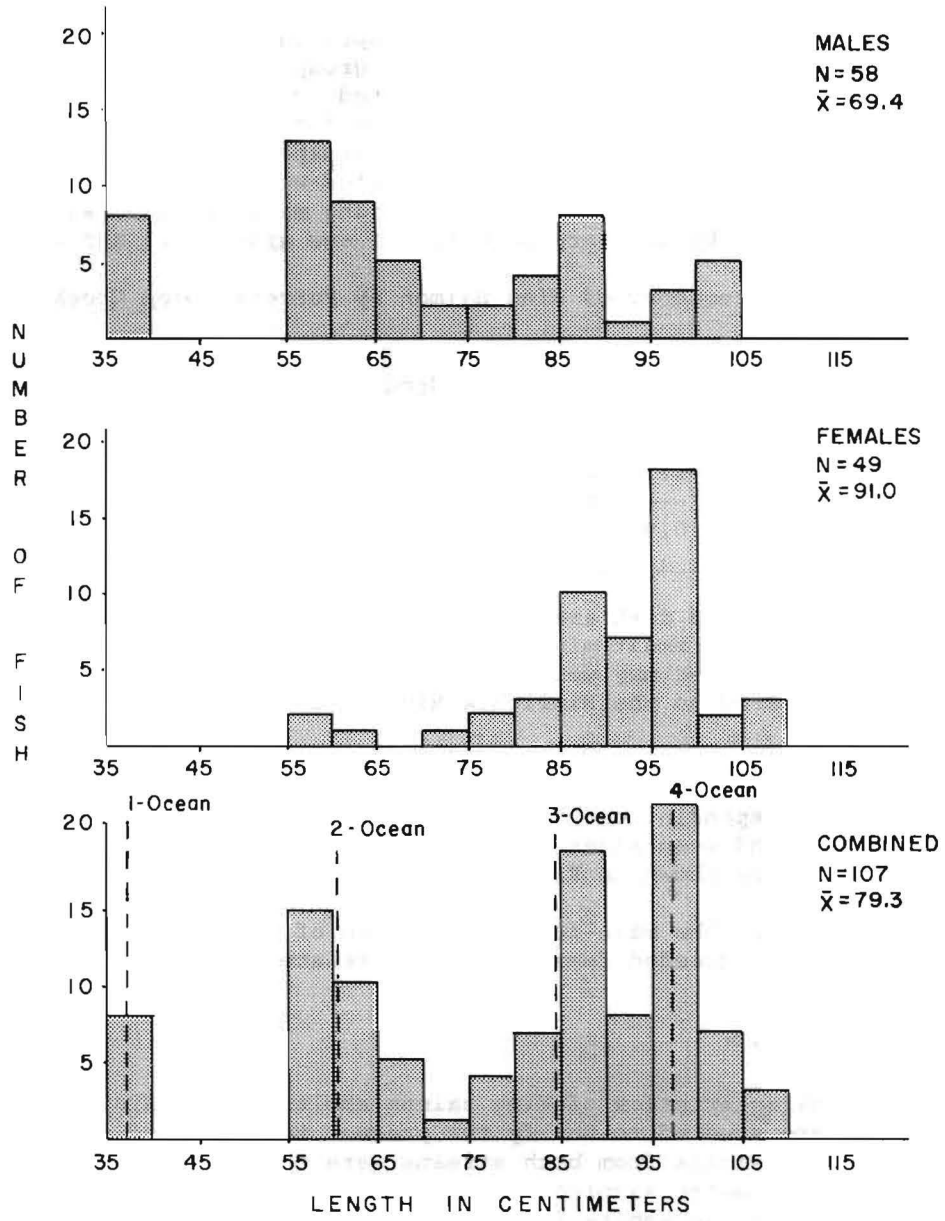

FIGURE 2. LENGTH-FREQUENCY OF SPORT CAUGHT KING SALMON, DEEP CREEK, 1967.

TABLE 10 - Circuli Counts and Size Distribution of King Salmon Smolts, Ninilchik River, June 23, 1967.

Number of Smolts	Length (mm)	Annulus									Average Total Number Of Circuli
		5	6	7	8	9	1	2	3	4	5
1	80-84	1						1			8
7	85-89		3	3		1	1	2	4		10.3
10	90-94		5	3	2			3	7		10.4
12	95-99		5	5	1	1		6	5	1	10.4
2	100-104			1		1		1		1	12.0
3	105-109		1	2				2	1		10.0
		Circuli Prior To Annulus					Circuli Past Annulus				

N=35
$\bar{X}$=94.3
CI (95%) = 94.3 ± 2.1 mm

TABLE 11. Circuli Counts and Size Distribution of King Salmon Smolts, Deep Creek, June 23, 1967.

Number of Smolts	Length (mm)	Annulus									Average Total Number Of Circuli
		5	6	7	8	1	2	3	4	5	
7	70-74	3	4	1			5	3			8.1
14	75-79	6	4	3	1	1	9	4			8.1
4	80-84		2		2		1	3			9.8
3	85-89		2		1		2	1			9.0
1	90-94			1				1			10.0
1	95-99				1					1	13.0
		Circuli Prior To Annulus				Circuli Past Annulus					

N=31
$\bar{X}$=78.4
CI (95%) = 78.4 ± 2.1 mm

Silver Salmon Studies

Anchor River:

Periodic creel checks were made during the silver salmon fishery to estimate angler success and timing of the run. Ten random creel checks were made between August 9 and August 30. Two hundred forty active anglers were interviewed. They reported fishing 486.5 hours and catching 112 silver salmon. Catch rates were 0.47 silver salmom per angler and 0.23 fish per hour. Due to time limitations, no creel census was conducted

after August 30; however, silver salmon were being harvested at a rate above the seasonal average on that date. Weir records show some silvers enter the Anchor River until about October 1 (Allin, 1954). The largest catches of silver salmon were made on August 23 and August 24. On August 24, forty-four anglers were checked with 55 silvers. Anglers reported even better fishing during the previous day.

It was noted that the bulk of the daily silver salmon catch occurs prior to 8:00 a.m. The moderate fishing pressure occurring throughout the remainder of the day takes few silvers. This diurnal variation in angler success should be considered in any future creel census of the silver salmon fishery.

Repeated, unsuccessful attempts were made to locate numbers of spawning silver salmon and to delineate index areas for yearly comparisons of population abundance. No large number of spawners could be found. The largest number of silver salmon seen was 12 individuals in Twitter Creek, tributary to the South Fork of the Anchor River.

Data were collected from 90 sport caught silver salmon. The sample contained 46 males and 44 females. Average sizes for males and females were 67.3 cm and 65.1 cm, respectively. Scales from 88 silver salmon were read for age determination and 85 were found to be age group 2.1. The remaining individuals were from age groups 1.1, 3.1, and 2.2.

Kachemak Bay:

A limited but expanding sport fishery for silver salmon exists in Kachemak Bay. Throughout the month of August, silver salmon remain in Mud Bay, just north of the Homer Spit. Due to lack of boat livery facilities, catches remain low. Individual creel checks in 1967 revealed as many as 46 anglers fishing from shore. By 1968, three businesses plan to rent skiffs for sport fishing near the Spit and catches can be expected to increase sharply. The area is sheltered and rough water is seldom a problem.

The silver salmon in Mud Bay also sustain limited commercial and subsistence fisheries. From 1963 through 1967, the commercial catch has averaged about 1,200 silver salmon. In 1967, fifty-one subsistence permittees caught 854 silver salmon from August 17 until the run terminated in early September.

The spawning site of the Mud Bay stock is unknown, but is popularly believed to be Clearwater Slough, tributary to Fox River, located in the northeast corner of Kachemak Bay. A foot survey covering the entire Clearwater Slough system enumerated only 31 silver salmon. Furthermore, suitable silver salmon spawning area was limited. The glacial Fox River may be used extensively for silver salmon spawning. Due to glacial color which remains until after the conclusion of silver salmon spawning, no surveys could be conducted on this stream.

Tustumena Lake:

Tustumena Lake, with a surface area of about 61,300 acres, is the largest body of water on the Kenai Peninsula. The lake is approximately 23 miles long and has an average width of 4 - 5 miles. Glacier and Indian Creeks, the major tributaries to Tustumena Lake, are glacial and are responsible for the silty color of the lake. All other tributaries are small, clear streams.

An access road, scheduled to be completed during the spring of 1968, will link the semi-isolated lake with the Kenai Peninsula highway system.

Because the Tustumena watershed is known to be the second largest salmon producer on the Kenai Peninsula, surveys were initiated within the drainage to: (1) assess the size and quality of anadromous fish stocks, (2) estimate the impact of increased human activities upon these stocks, and (3) provide recommendations for the recreational management of the area's fishery resource.

Four surveys, conducted between July 20 and October 13, revealed that 12 inlet tributaries were large enough to accommodate spawning salmon. Red salmon were observed in nine of these streams. Red salmon first enter Tustumena Lake during early June and begin to concentrate off stream mouths about July 7-15. Spawning commences in late July, peaks in mid-August, and is completed about September 15. Red salmon, upon nearing sexual maturity, school off the mouth of their natal stream. The recreational harvest of these fish would be undesirable because of their vulnerability and advanced sexual condition.

Silver salmon enter the system from mid-July until late fall. Silvers are known to spawn in Nikolai Creek, Shantatalik Creek, and Indian Creek and have been reported to use Seepage and Glacier Flat Creeks. Silver salmon, in prime physical condition, arrive off stream mouths after most red salmon have migrated into the inlet streams. A very small sport fishery has been active for several years at the mouths of Nikolai and Shantatalik Creeks.

Quality angling for Dolly Varden, Salvelinus malma, is available in many tributaries throughout the summer and fall. Rainbow trout are also common throughout the drainage.

Hazardous water conditions may be a major deterrent to the recreational utilization of Tustumena Lake. Strong winds, producing ocean-like waves, frequently sweep the lake. Shorelines tend to be straight and very few sheltered areas are available to the small boat operator.

Detailed survey records for all work performed in the Tustumena watershed are on file at the Soldotna office of the Alaska Department of Fish and Game.

Steelhead Trout Studies

Anchor River:

A partial creel census was carried out on the Anchor River to collect population data on steelhead trout. Data were collected from only 37 adult steelhead. The total angler harvest could not be estimated.

Age grouping was determined for the 1967 sample and an addtional 86 steelhead scales collected from the Anchor River in 1960 were read for comparison. Length frequency data for the 1960 sample were previously published by Dunn (1960). Table 12 summarizes population characteristics for both the 1960 and 1967 samples. Conclusions regarding such small samples are tenuous. However, certain similarities between both samples are apparent and indicate that some general conclusions are justified.

TABLE 12 - Population Characteristics of Steelhead Caught In Sport Fishery, Anchor River, 1960 & 1967.

	1960						
Age Group	2.2	2.3	3.1	3.2	3.3	3.4	Total
Number of Fish	5	0	25	48	7	1	86
Percent of Total	5.8	0	29.1	55.8	8.1	1.2	100
Average Size (cm)	70.5	0	58.5	69.5	70.5	89.4	66.7
Number of Post Spawners	0	0	0	1	6	0	7
Number of 2nd Spawners	0	0	0	1	1	1	3

	1967						
Age group	2.2	2.3	3.1	3.2	3.3	3.4	Total
Number of Fish	1	2	6	12	9	7	37
Percent of Total	2.7	5.4	16.2	32.4	24.3	18.9	100
Average Size (cm)	73.7	64.8	56.8	65.3	76.4	83.3	70.2
Number of Post Spawners	0	2	0	3	5	2	7
Number of 2nd Spawners	0	0	0	0	2	7	9

Most scales were interpreted to have three annular freshwater checks before emigration to salt water. Withler (1966) in a survey of nine British Columbia steelhead populations found the occurrence of 3-check smolts to range from 25.1 to 82.7 percent and average 59.1 percent. Since the Anchor River is near the northern boundary of steelhead range, where growth rates are typically depressed, 3-check smolts would be expected to predominate.

Females predominated in the 1960 and 1967 samples, and at the FWS weir in 1957 (Allen, 1957). Between 53 percent and 74 percent of each sample were females. Withler (1966) reported that the male-female sex ratio is near 1:1 for fish making their initial spawning migration. However, due to the influence of disproportionately greater survival of females past spawning activities, populations having a high percentage of repeat spawners tend to have a greater proportion of females.

It is interesting to note the similarity of the age class structures of the 1960 and 1967 samples. In both cases the predominant age group of

adults returning for their initial spawning was age group 3.2 with age group 3.1 about one-half as numerous. If the repeat spawners are excluded, the percentage of age groups 3.1 and 3.2 is almost identical in both samples.

A definite difference between the samples is the percentage of repeat spawning. On scales from the 1967 sample, 24.3 percent (9/37) were interpreted to possess a spawn check from a prior year. In the 1960 sample, only 3.5 percent (3/86) were interpreted to have spawned previously. Allin (1954) reported that 16 percent of a 60-fish sample in 1954 had one previous spawn check while 10 percent had two checks.

The greater percentage of previous spawners in the 1967 sample is supported by length frequency data in Figure 3. In the 1960 sample only 2.2 percent (2/93) exceeded 80.0 cm.

All spawn checks on both the 1960 and 1967 scales indicated one winter spent in the ocean between spawning migrations. Allin (1957) stated that three tagged post-spawning Anchor River steelhead had been recovered during the following pre-spawning migration, indicating consecutive year spawning. However, Allin did not discuss the gonadal condition of these individuals. Consecutive year spawning in the Anchor River infers a fish which spawns in May, enters the ocean in June, and re-enters the stream about three months later to spawn again. Possibly the individuals mentioned by Allin were not prepared to spawn on the succeeding migration.

Average lengths for the various age groups as shown in Table 12 are influenced by inclusion of fish taken during the spring post-spawning migration. Those individuals having spent an average of nine months in fresh water, probably not feeding, would exhibit little if any growth and depress the average length of the age group.

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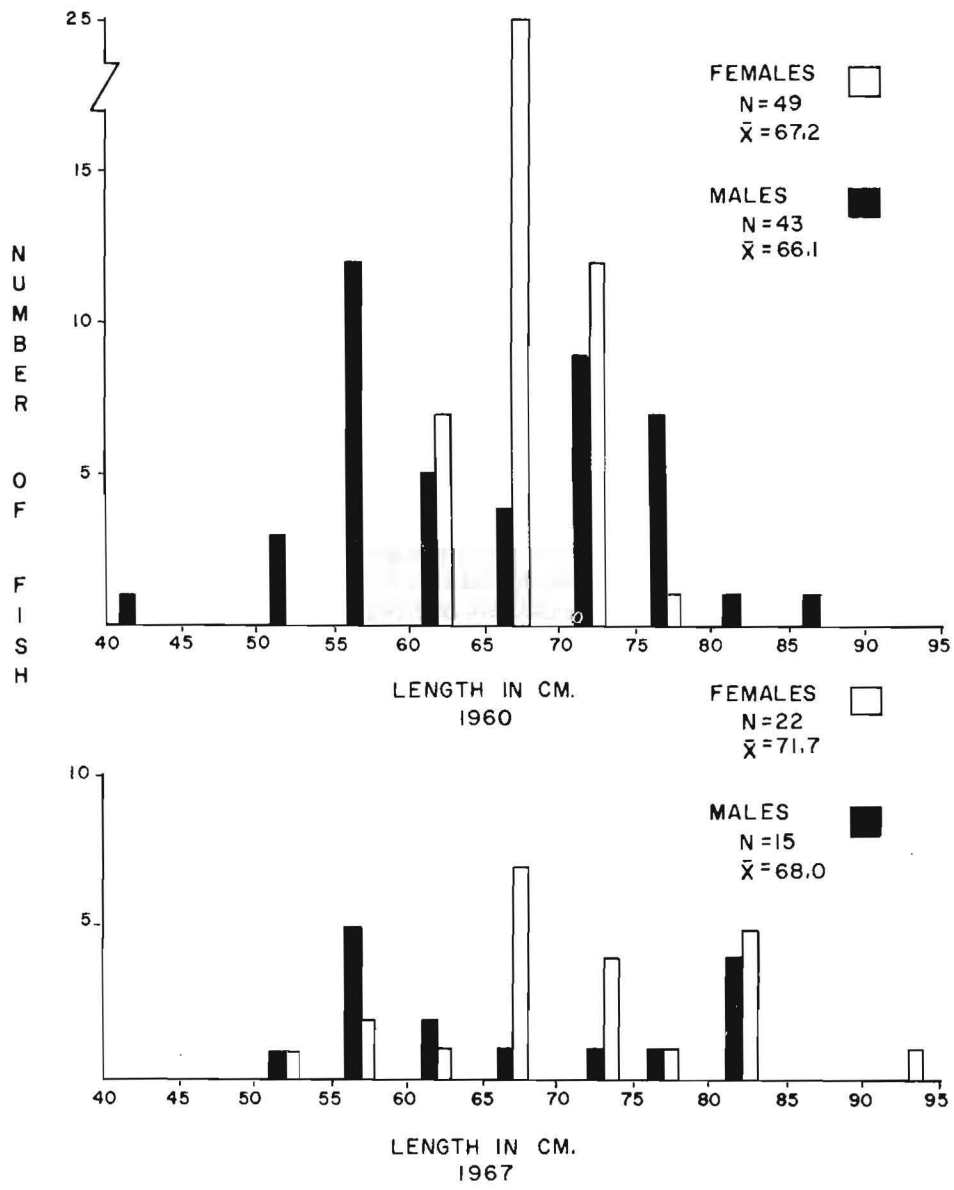

FIGURE 3. LENGTH-FREQUENCY OF SPORT CAUGHT ANCHOR RIVER STEELHEAD, 1960 and 1967.

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